

Annual Report 2004-2005 – Integrated Status and Effectiveness Monitoring

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Developing monitoring protocols for assessing productivity and watershed condition in headwater subcatchments of the Wenatchee Basin

ABSTRACT

Low order streams dominate drainage networks and have been documented to transport substantial amounts of energy and nutrients to downstream habitats. Less is known, however about variation in the amount of transport that occurs across climatic and disturbance gradients and whether a consistent response among component species in the aquatic food web can be observed. The goals of this research are to: 1) develop and test methods for monitoring headwater stream conditions at the subcatchment and stream levels, 2) determine the effects of land-use (timber harvest and roads) and ecoregion (wet vs. dry) on the production of macroinvertebrates, and 3) determine whether watershed condition in fishless reaches can influence fish production in fish-bearing reaches. We completed the selection of 60 headwater stream sites by November 2004, all of which are located within the Wenatchee subbasin. We sampled these streams bimonthly from February-June 2005, to collect aquatic invertebrate and organic/inorganic drift in a subset of streams. An approximately equal number of streams were sampled from each category (wet and dry ecoregion crossed with low and high impact), though only 20 were sampled in February due to access limitations in the winter. Preliminary analyses of these data indicate that sites in the dry ecoregion transport more invertebrates downstream and that ecoregions differ in several abiotic variables (e.g. higher conductivity and pH). How these subsidies potentially influence downstream fish assemblages will be the primary focus of future research.

Introduction

Low-order streams ($\leq 1^{\text{st}}$ order; typically fishless streams) comprise more than 80% of drainage networks, yet little is known about the role they play in affecting downstream fish habitats and communities (Benda and Dunne 1997, Gomi et al. 2002). Wipfli and Gregovich (2002) found that small fishless streams can be important energy sources for downstream food webs in southeastern Alaska, transporting invertebrates and organic material produced in headwaters environments to habitats lower in the drainage that contain fish. Understanding the ecological function of these headwater channels and associated subcatchments, and developing monitoring tools for assessing their condition is crucial for a broader understanding of basin-wide watershed condition, and for restoration effectiveness monitoring. Techniques developed by Wipfli and Gregovich

(2002) in southeastern Alaska could prove very effective for assessing the biological condition of small drainages in general, and therefore the cumulative effects of land use and watershed condition. Coupled with measuring selected fish community metrics (e.g., lipids, density, growth rates, etc.) in the habitats these small streams drain into, we intend to link watershed condition with stream productivity, food resources for fishes, and ultimately fish condition.

This work represents an opportunity to develop a novel, innovative approach for watershed assessment by directly monitoring the productivity of food webs (arguably the ultimate response of the health of stream ecosystems), and indirectly all the cumulative processes and factors (e.g., organic / inorganic matter load and dynamics, flow regime, light, nutrient dynamics, water temperature, geology, land-use, and watershed condition) that drive it. It is important to emphasize that this work focuses on food web productivity of low order streams as a means for testing and developing a new tool for monitoring watershed condition and restoration effectiveness. This approach is novel for three reasons: (i) food web monitoring gets right to the bottom line and integrates the stressors, processes, and conditions that ultimately drive these ecosystems; (ii) it directly links headwater condition and downstream fish productivity; (iii) these low order watersheds comprise over 80% of typical drainage networks, therefore in aggregation have great potential to influence salmonid habitats downstream; and (iv) monitoring in these low order watersheds has been historically ignored.

Objective

In collaboration with the University of Alaska at Fairbanks, our headwater-monitoring program focuses on the production and ecological diversity of aquatic macroinvertebrates that can potentially be exported to fish habitats as an integrator of the processes and environmental constraints driving these ecosystems. It is also meant to determine whether food web productivity is a key determinant of the health of downstream fish communities.

Project Area

Our 60 stream sites are located within the Wenatchee subbasin and are evenly distributed among the four land-use (low versus high impact) and ecoregion (wet vs. dry) categories. The sites occur in the Mission Creek, Peshastin Creek, Icicle, Little Wenatchee, Nason Creek, and White River drainages.

Methods

Working with cooperators at the University of Alaska at Fairbanks, we have selected 60 stream sites located within the Wenatchee subbasin for sampling. Half (30) of these streams are located in Ecological Sub-Region (ESR) 4 (wet ecoregion) with the other 30 in ESR 11 (dry ecoregion). Differences among ecoregions are designated by differences in vegetation type, temperature, precipitation, and solar radiation (Hessburg et al. 2000). In both ecoregions, 15 low (little past logging and presence of roads) and high impact (recent logging and roads) sites have been chosen.

Macroinvertebrate samples were collected using a 250- μm net attached to one end of a 75-cm long, 10 cm^2 area rectangular opening plastic pipe, which rested on the stream bottom. Both stream and pipe discharge was measured during each sampling period, a mean calculated, and this value used to determine the density of invertebrates (individuals m^{-3}), organic, and inorganic matter (g m^{-3}). Many streams were sufficiently small to allow for the entire stream flow to pass through the pipes. Physical measurements (temperature, dissolved oxygen, conductivity, riparian vegetation, and algal production) were taken concurrently with invertebrate samples. Between each of these sampling occasions, PNW laboratory technicians processed the invertebrate samples, quantifying the number of individuals and biomass of all macroinvertebrates. This required additional calibration of existing regression relationships for each species to calculate total mass from body length.

Fish were captured downstream of sampling sites at eight streams using both dip and seine nets. We anesthetized individuals of all species with MS-222[®] and use gastric lavage techniques (Meehan and Miller 1978) to obtain a sample of consumed prey. Gut contents were preserved in alcohol and will be analyzed in the laboratory to determine whether the assemblage of taxa consumed by fish can be linked to headwater production.

Results Summary

A total of 254 drift samples have been collected to date, with 23 sites sampled in September 2004, 31 in November 2004, 20 in February 2005, and all 60 sites sampled in April, June, and August 2005. We have begun to process and analyze our samples to determine the number and biomass of invertebrates, and the mass of both organic and inorganic matter captured from each of the sampled streams. We also have initiated analysis for the basic water chemistry data (temperature, conductivity, dissolved oxygen, pH), and nutrient data (e.g. nitrogen and phosphorus).

The ecological subregion factor is dominating our preliminary results. Streams within the dry ecoregion have thus far significantly higher conductivity, pH and number and biomass of invertebrates drifting than other sites. However, these results do not include invertebrate, organic, and inorganic data from the spring and summer sampling. We hypothesize that with further data analysis and sampling of all streams over the next year, sites will cluster into four groups based on ecoregion and land use. For example, we have completed initial reach scale vegetation analysis at all of our streams. There is substantial variation in the proportion of conifers and deciduous species located in surrounding riparian zones. Of particular interest is the higher density of alder species that surround streams that have been recently logged, since this variable has been documented to affect invertebrate subsidies in Alaska.

Tasks in progress at the time of this report

Macroinvertebrate sampling continues through June, August and October 2005. Because we have relative species abundances, we will be poised to assess community-level variation in space and time. Preliminary studies of fish population ecology and behavior began in late June of 2005. This information will define the tractability of proposed field assays and experiments.